

Space Weather Technical Forecast

Issued on Wednesday, 14 September 2022 at 13:26 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales <https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales>

Space Weather Forecast Headline: Chance of G1/Minor Storms days 1 to 4 (14th to 17th). M-class flares considered likely. Ongoing Active electron fluence.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity has been Moderate, with an impulsive M1.1 flare observed around 14/1018 UTC from AR3098. There are four sunspot regions on the disk. AR3098 in the northwest quadrant remains the largest and most complex spot. AR3100, is elongated but only has one significant spot. The remaining significant region, AR3102 has rotated onto the southeast limb with a large leader and small trailing spot. The remaining unnumbered region is small and simple. There is evidence that a relatively weak transient feature arrived at L1 just after 14/0600 UTC. So far any responses on Earth have been muted. No new Earth-directed CMEs were evident in imagery.

Solar Wind / Geomagnetic Activity: Despite the possible CME arrival the solar wind speed at L1 has remained at background levels. Density was below average but increased above average following the CME arrival. The total magnetic field strength was weak below 5nT before becoming Moderate following the CME with a peak of 11nT at 14/0913 UTC. The north-south component remains weak fluctuating between +5/-5 nT. Phi angle was positive (away from the Sun) until 14/0042 UTC when it rotated into a negative (towards the Sun) configuration. At 14/0840 UTC it returned to negative. Geomagnetic activity was Quiet.

Energetic Particles / Solar Radiation: The high energy proton flux (greater than 10 MeV) as measured at GOES16, has been slightly elevated reaching 2.92 pfu at 14/0640 UTC. Electron flux was high, briefly becoming Moderate between 14/ 0830-0930 UTC, reaching a peak value of 7910 pfu at 14/1010 UTC. The corresponding 24-hour electron fluence remained above Active (1e8 integrated pfu) with a generally rising trend, resulting in a 14/0000 UTC observed value of 2.15e8 integrated pfu.

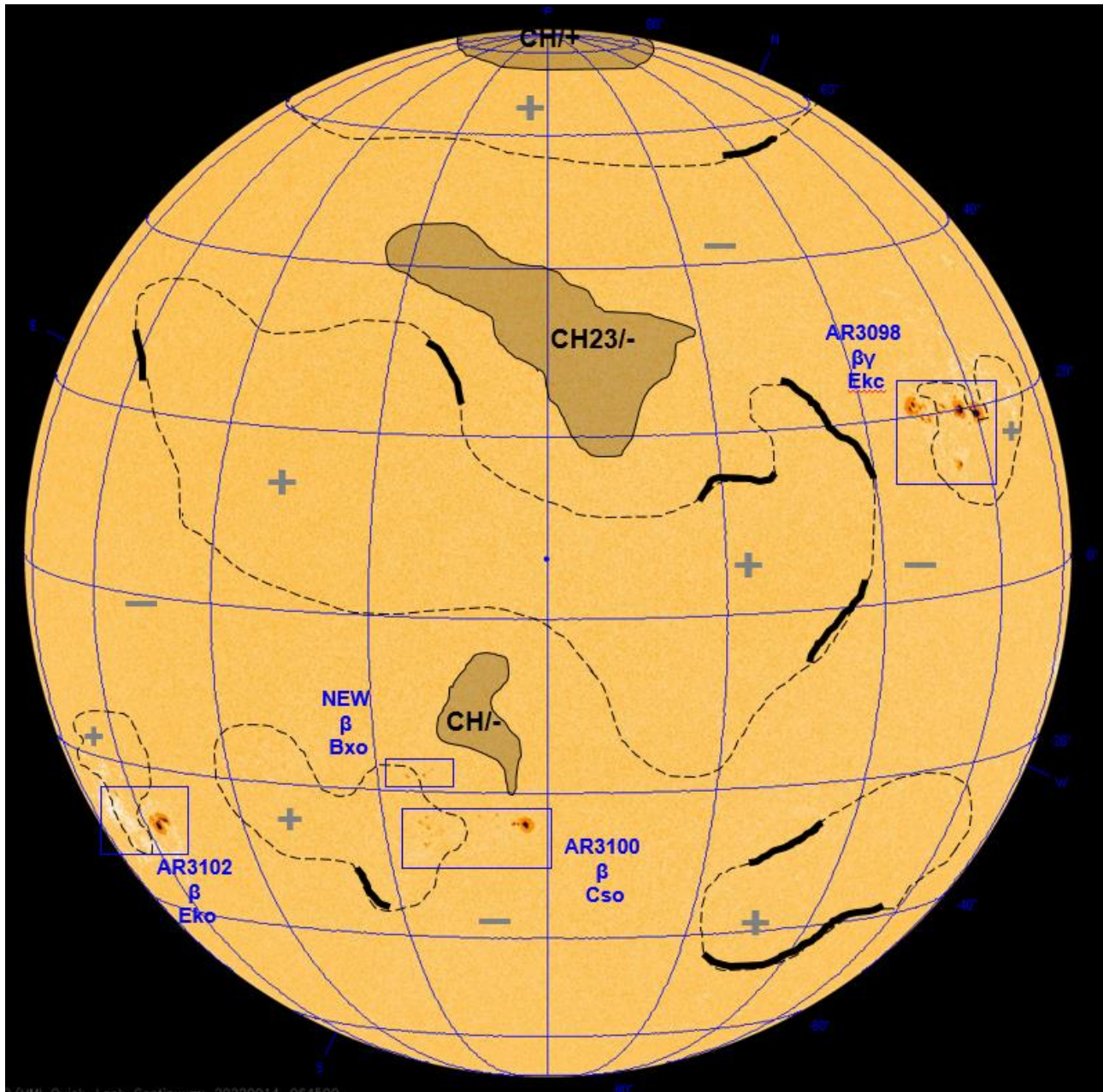
Four-Day Space Weather Forecast Summary

Solar Activity: Further M-class flares are considered likely with a slight chance of X-class flares.

Solar Wind / Geomagnetic Activity: A CME which was observed leaving the Sun on 11 September may have arrived at L1 around 14/0620 UTC, though responses on Earth, thus far, have been muted. CH23/- may become geoeffective later on day 3 (16th), perhaps bringing elevated solar wind speeds until the end of the period. Geomagnetic activity is forecast to be mainly Quiet to Unsettled through the period, with Active intervals likely and a chance of G1/Minor Storms day 1 to 4 (14th-17th), this is due to the CME arrival and then the HSS from CH23/-, although the forecast is low confidence.

Energetic Particles / Solar Radiation: High energy protons (greater than 10 MeV), while slightly elevated, are expected to remain below S1/Minor radiation storm levels. The high energy (greater than 2 MeV) electron flux is currently mainly High, though it is expected to dip back into Moderate levels at diurnal minimum, with more prolonged periods at Moderate likely should we see any significant prolonged geomagnetic activity. This trend is expected to continue to ease through the period, though the arrival of faster solar winds on the 16th may increase electron flux again. The corresponding 24-hour fluence is expected to remain above Active (1e8 integrated pfu) until day 2 or 3 (15th or 16th).

Figure 1. Solar Analysis Valid 14/0700 UTC.



Key: Filament — , Prominence — , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

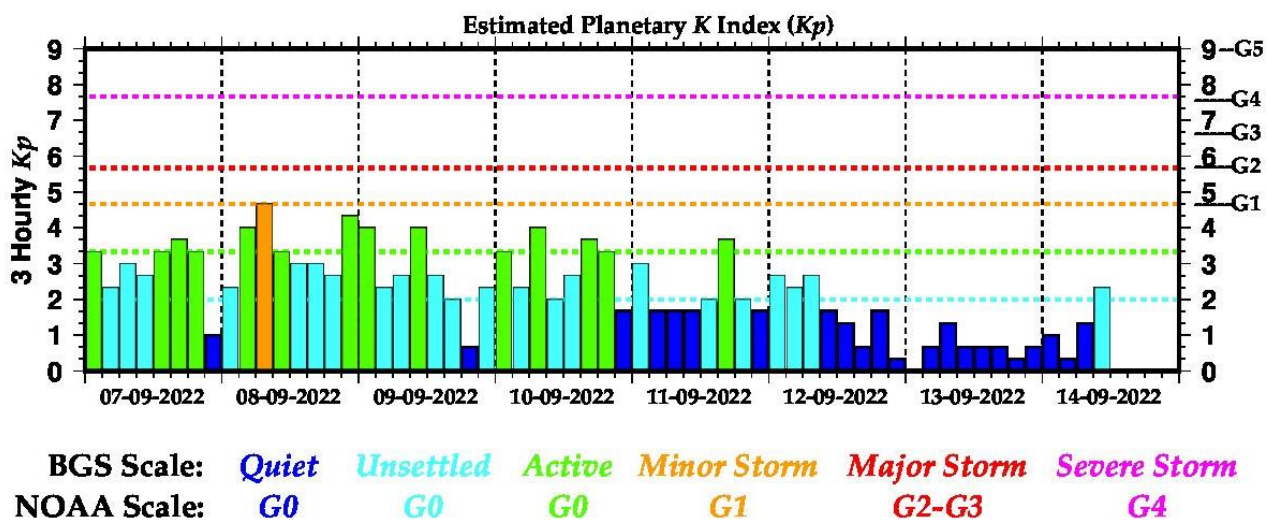
Geomagnetic Storms:

A filament eruption was observed leaving the north centre of the Sun around 11/1200 UTC. This CME may have arrived at L1 around 14/0620 UTC. Currently geomagnetic response at Earth remain muted, though given the increase in density and the possibility that Earth may remain within the magnetic cloud from this feature for a significant period, if we see an extended period of negative Bz there is a chance of G1 Minor Geomagnetic storms through to day 2 (15th). The high speed stream from coronal hole 23 is then forecast to connect with Earth anytime from midday day 3 (16th), though due to its negative polarity as we approach the autumn equinox, significant geomagnetic enhancement is thought to be unlikely.

Geomagnetic activity is forecast to be mainly Quiet to Unsettled through the period, with Active intervals likely and a chance of G1/Minor Storms due to CME influences at first and then the arrival of the High Speed Stream from CH23/- from day 3 (16th).

Geo-Magnetic Storm	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Minor or Moderate	G1 to G2	No	25	25	25	25
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Figure 2: BGS estimated planetary K index (Kp)

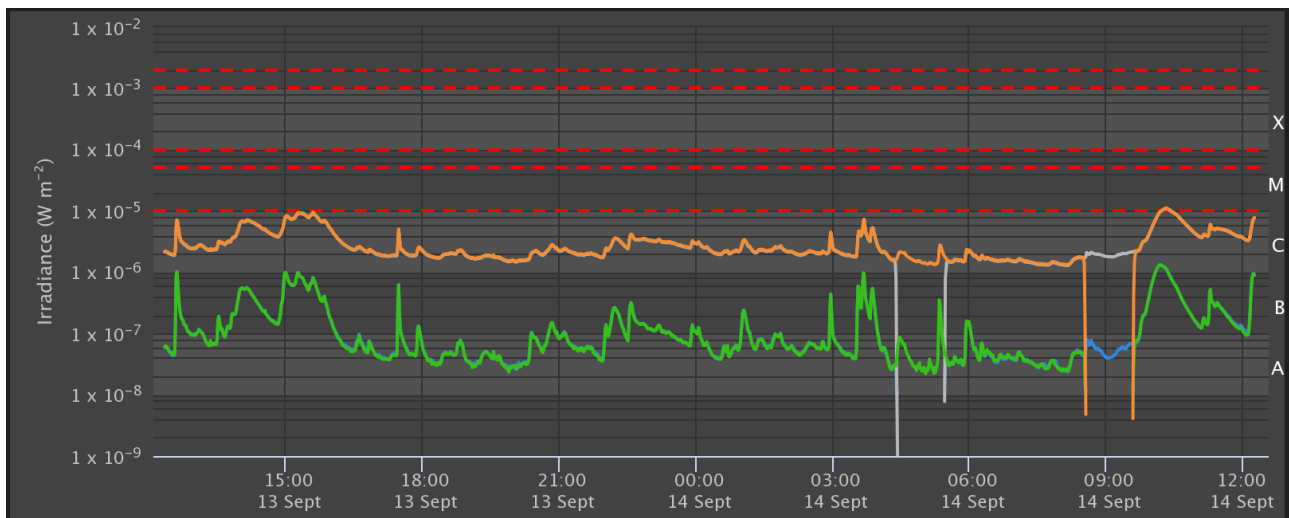


Radio Blackouts - X-Ray Flares:

The most significant sunspot region on the disc remains AR3098 (Ekc/ $\beta\gamma$), this region produced an M1.1 flare at 14/1019 UTC, and a long duration C9 flare around 13/1500 UTC. There are two other notable spots on the disk, AR3100 and AR3102, though neither are currently contributing with any moderate class flares. Further M-class flares are considered likely.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	No	60	60	60	60
Very Active	R3 to R5 X Class	No	10	10	10	10

Figure 3: GOES16 X-Ray flares



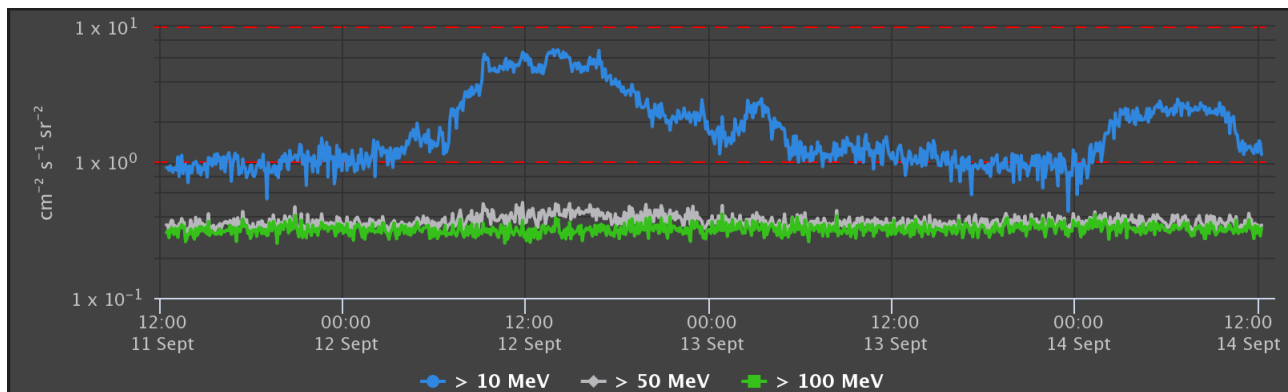
Solar Radiation Storms - (High Energy Protons):

The high energy proton flux (greater than 10MeV) remains slightly elevated though is not expected to reach S1 proton storm levels. Though there is a slight chance that due to the location of AR3098, should a substantial flare and CME erupt from the spot, an increase in proton levels may rise above S1 Storm.

Radiation Storms	Level ($\text{cm}^{-2} \text{sr}^{-1} \text{s}^{-1}$)	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	$\geq \text{S1}$	No	10	10	10	10
Very Active	$\geq \text{S3}$ *	No	1	1	1	1

* S3 $\geq 10 \text{ MeV} \geq 1000 \text{ pfu}$ and / or $\geq 50 \text{ MeV} \geq 10 \text{ pfu}$. (pfu = $\text{cm}^{-2}\text{sr}^{-1}\text{s}^{-1}$)

Figure 4: High Energy Protons remain slightly elevated but below S1 levels.



High Energy Electrons Event ($\geq 2\text{MeV}$):

High energy (greater than 2MeV) electron flux has been at mainly high levels through the last 24 hours. However, the diurnal peaks are expected to continue falling as the radiation in the belts slowly dissipate as the solar wind eases with further losses expected due to any geomagnetic enhancements following the CME arrival. A faster solar wind from day 3 (16th) may increase the ElectronFlux, though this will be countered by any geomagnetic response.

Electron fluence values are expected to follow a declining trend through the next four days, with low confidence toward the end of the period due to possible geomagnetic activity from CMEs and Coronal Hole HSS.

GEO Electron Environment	Level ($\text{cm}^{-2} \text{sr}^{-1} \text{day}^{-1}$)	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	$\geq 2 \text{ MeV}$ $\geq 1 \times 10^8$	Yes	100	70	50	40
Very Active	$\geq 2 \text{ MeV}$ $\geq 1 \times 10^9$	No	1	1	1	1

Figure 5: GOES16 ElectronFlux (top) remains mostly above the 1000pfu Alert level. Observed fluence levels (in blue below) remain above the $1\text{e}8$ integrated pfu Active level.

